

Topic 02 – SL/HL Atomic Structure Exam MS

1. B (sL7)(hL6)
2. C (sL5)(hL5)
3. A (sL4)(hL4)
4. C (sL6)(hL5)
5. B (sL5)(hL4)
6. C (sL7)(hL6)
7. B (sL5)(hL5)
8. C (sL5)(hL5)
9. D (sL5)(hL5)
10. D (sL6)(hL5)
11. B (sL5)(hL4)
12. C (sL4)(hL3)
13. C (sL6)(hL5)
14. A (sL5)(hL5)
15. D (sL5)(hL5)

SL Legend		Free Response Section (Paper 02)												
Level:	Needed	Grade	Possible	3	4	5	6	7	Cutoff					
Above +6	0%	2	0	50%	4	40%	3.6	30%	4.5	20%	0.4	10%	0.7	13
Above +5	10%	3	5	80%	4	50%	4.5	40%	6	30%	0.6	20%	1.4	17
Above +4	20%	4	9	90%	4.5	80%	7.2	50%	7.5	40%	0.8	30%	2.1	22
Above +3	30%	5	15	95%	4.5	90%	8.1	80%	12	50%	1	40%	2.8	28
Above +2	40%	6	2	100%	5	95%	8.55	90%	13.5	80%	1.6	50%	3.5	32
Above +1	50%	7	7	100%	5	100%	9	95%	14.3	90%	1.8	80%	5.6	36
Level		Multiple Choice Section (Paper 01)												
Below -1	90%	Grade	Possible	3	4	5	6	7	Cutoff					
Below -2	95%	2	0	50%	0	40%	0.8	30%	2.4	20%	0.6	10%	0.2	4
Below -3	100%	3	0	80%	0	50%	1	40%	3.2	30%	0.9	20%	0.4	6
Below -4	100%	4	2	90%	0	80%	1.6	50%	4	40%	1.2	30%	0.6	7
Below -5	100%	5	8	95%	0	90%	1.8	80%	6.4	50%	1.5	40%	0.8	11
Below -6	100%	6	3	100%	0	95%	1.9	90%	7.2	80%	2.4	50%	1	13
Below -7	100%	7	2	100%	0	100%	2	95%	7.6	90%	2.7	80%	1.6	14

HL Legend		Free Response Section (Paper 02)												
Level:	Needed	Grade	Possible	3	4	5	6	7	Cutoff					
Above +6	0%	2	0	50%	2.5	40%	3.6	30%	5.4	20%	0.8	10%	0.2	13
Above +5	10%	3	5	80%	4	50%	4.5	40%	7.2	30%	1.2	20%	0.4	17
Above +4	20%	4	9	95%	4.8	80%	7.2	50%	9	40%	1.6	30%	0.6	23
Above +3	30%	5	18	100%	5	95%	8.55	80%	14.4	50%	2	40%	0.8	31
Above +2	40%	6	4	100%	5	100%	9	95%	17.1	80%	3.2	50%	1	35
Above +1	50%	7	2	100%	5	100%	9	100%	18	95%	3.8	80%	1.6	37
Level		Multiple Choice Section (Paper 01)												
Below -1	95%	Grade	Possible	3	4	5	6	7	Cutoff					
Below -2	100%	2	0	50%	0.5	40%	1.2	30%	2.7	20%	0.4	10%	0	5
Below -3	100%	3	1	80%	0.8	50%	1.5	40%	3.6	30%	0.6	20%	0	7
Below -4	100%	4	3	95%	1	80%	2.4	50%	4.5	40%	0.8	30%	0	9
Below -5	100%	5	9	100%	1	95%	2.85	80%	7.2	50%	1	40%	0	12
Below -6	100%	6	2	100%	1	100%	3	95%	8.55	80%	1.6	50%	0	14
Below -7	100%	7	0	100%	1	100%	3	100%	9	95%	1.9	80%	0	15

16. (a) (5x1) $III < II < I < IV$ /
ultra violet radiation < blue light < orange light < infrared radiation; 1
- (b) (5x4) All electrons begin in the “excited state” at $n=5$;
UV, falls from $5 \rightarrow 1$;
Blue, falls from $5 \rightarrow 2$;
Orange, falls from $5 \rightarrow 3$;
IR, falls from $5 \rightarrow 2$
If the electron travel is correct, but in the wrong direction award 3 max
ECF: If the part (a) is incorrect but part (b) is correctly based on the response, award full points. 5
17. (a) (4x1) mole ratio N:H = $\frac{87.3}{14.01} : \frac{12.6}{1.01} = 6.23 : 12.7$; 1
No penalty for using integer atomic masses.
 $N_{6.23}H_{12.7} / 6.23$
(5x1) empirical formula is NH_2 1
- (b) (7x1) Relative Molecular Mass: $6.41 \text{ g} / 0.20 \text{ mol} = 32.05 \text{ g/mol}$ 1
(5x1) Molecular Formula: $32.05 / 16.03 = 2$ (16.03 is the mass of NH_2) $2x NH_2 = N_2H_4$ 1
18. (a) (5x1) atoms of the same element/same number of protons/same atomic number;
(3x1) having different numbers of neutrons/different (mass number); 2
Award only [1] max if reference made to elements but not atoms.
- (b) (5x2) relative atomic mass = $\frac{36 \times 0.337 + 38 \times 0.0630 + 40 \times 99.6}{100}$; 2

[6]

[4]

(c) (4x2) 23 electrons; 26 protons; 30 neutrons;		2	
<i>Award [2] for three correct, [1] for two correct.</i>			
19.	(a) (3x1) continuous spectrum has all colors/wavelengths/frequencies whereas line spectrum has only (lines of) sharp/discrete/specific colors/wavelengths/frequencies;	1	[6]
	(b) (7x1) lines get closer together towards high energy;	1	
20.	(i) (5x1) $1s^2 2s^2 2p^6 3s^2 3p^6$; <i>Do not accept [Ne] $3s^2 3p^6$ or 2, 8, 8. (ok for SL)</i>	1	
	(ii) (6x2) $K^+ / Ca^{2+} / Sc^{3+} / Ti^{4+}$; $Cl^- / S^{2-} / P^{3-}$; <i>Accept other suitable pairs of ions.</i>	2	
22.	(i) (3x1) number of protons in the nucleus/atom; <i>Do not accept protons and electrons.</i>	1	[3]
	(ii) (3x1) number of protons and neutrons in the nucleus/atom;	1	
23.	Si (5x1) 2.8.4/2,8,4;		[2]
	P^{3-} (5x1) 2.8.8/2,8,8;	2	
24.	(i) (3x1) (4x1) ratio of <u>average</u> mass of an atom to $\frac{1}{12}$ the mass of C-12 isotope/ <u>average</u> mass of an atom on a scale where one atom of C-12 has a mass of 12/sum of the weighted <u>average</u> mass of isotopes of an element compared to C-12/OWTTE;	1	
	<i>Award no mark if 'element' is used in place of 'atom'</i>		
	(ii) (4x1) ^{63}Cu (more abundant) since $A_r(Cu)$ is closer in mass to 63; <i>Explanation needed for mark</i>	1	
25.	(4x1) 16 protons and 17 neutrons and 18 electrons;	1	[2]
26.	(a) (i) (4x1) to produce positively charged ions; (5x1) by the bombardment of fast moving electrons;	2	
	(ii) (4x1) magnetic field at right angles to path of ions/accept suitably labeled diagram; (5x1) moves ions in curve path/deflects ions; dependent on mass/charge ratio;	2	
	<i>Award [1] each for any 2 points.</i>		
	(iii) (4x1) acceleration of the ions by electric field/towards negative plate/cathode;	1	
	(b) (i) (sL 7x2) (hL 6x2) $A_r(Rb) = 85.47 = \frac{85x + 87(100 - x)}{100}$; <i>Accept other valid mathematical alternatives.</i>		
	$^{85}Rb = 76.5$ and $^{87}Rb = 23.5\%$;	2	
	(ii) (sL 7x1) (hL 5x1) Si: $1s^2 2s^2 2p^6 3s^2 3p^2$; (sL 7x1) (hL 5x1) Fe^{3+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$; (sL 7x1) (hL 5x1) P^{3-} : $1s^2 2s^2 2p^6 3s^2 3p^6$;	3	
	<i>Allow [1 max] for 3 correct abbreviated structures using noble gas symbols.</i>		

[10]